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(54) Manufacture of similarly shaped components

(57) A method of manufacturing a pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately located a predetermined distance apart when the components, in use, are spaced one from another, comprises the steps of, providing a pair of sheets of eg titanium alloy 30, 32, interleaving the sheets of the titanium alloy with a sheet 34 of pure titanium to form a laminate of the pure titanium between two sheets of the titanium alloy, superplastically moulding the laminate to a predetermined non-planar configuration, fixing the moulded laminate in the non-planar configuration, removing the laminate from the mould, separating the sheets of the titanium alloy from the moulded laminate, and discarding the sheet of pure titanium. Other materials exemplified include steel, nickel alloys, aluminium, aluminium alloys and polymeric materials. The products may be used as components in jet engines eg a splitter nose.

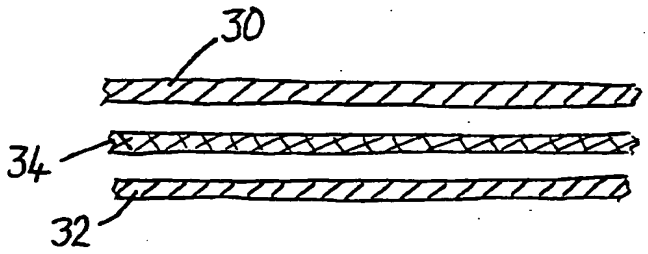

Fig 2

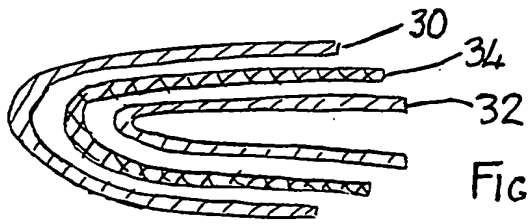

Fig 5

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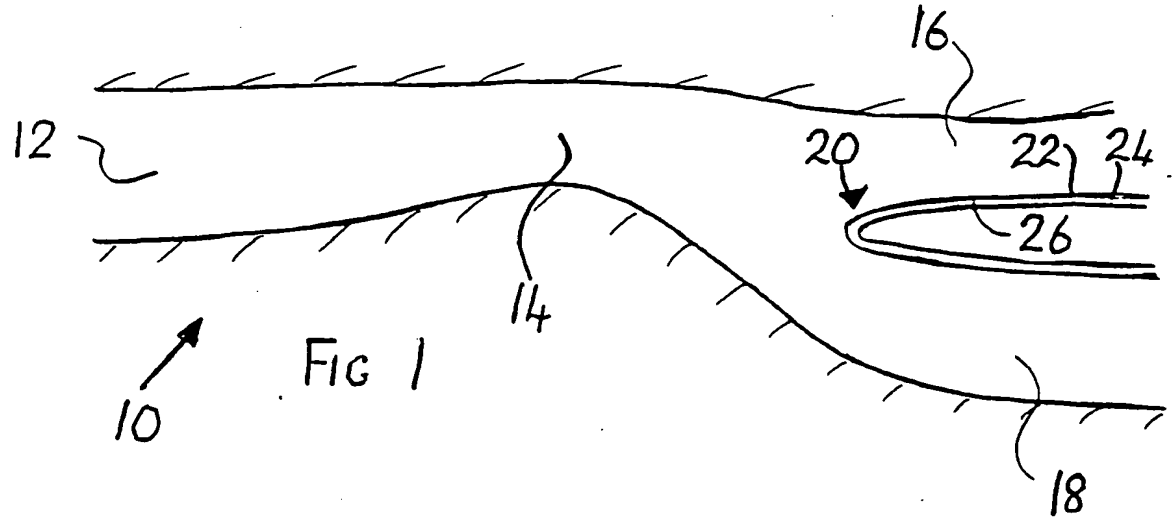

FIG 1

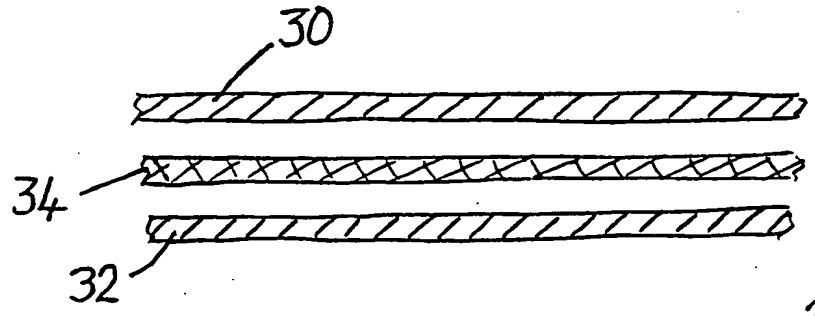

FIG 2

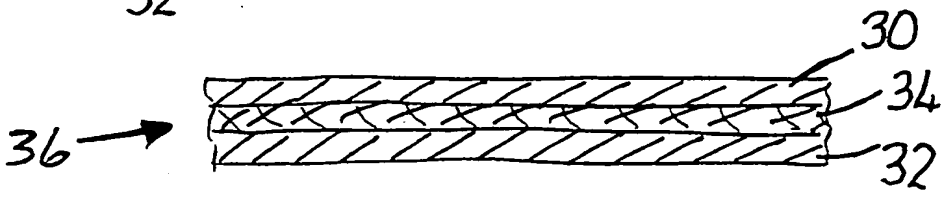

FIG 3

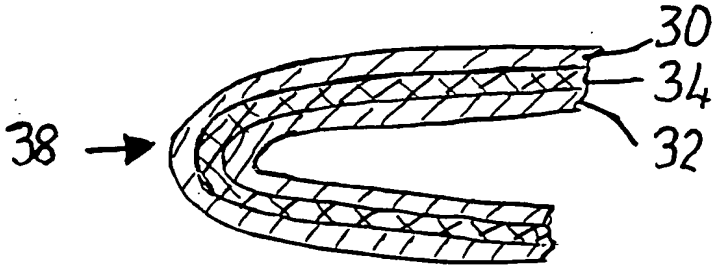

FIG 4

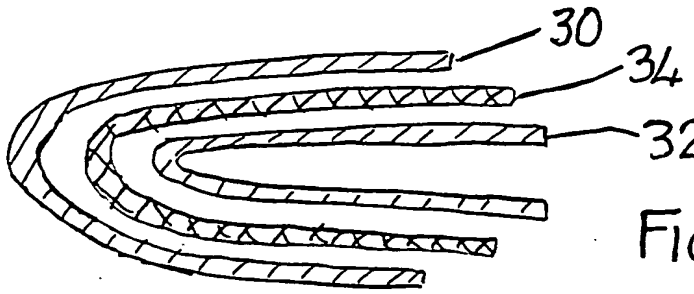

FIG 5

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IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF SIMILAR COMPONENTS

This invention concerns improvements in or relating to the manufacture of similar components and in particular concerns, in a first aspect, a method of manufacturing a number of similar non-planar components which in use are spaced one from another so that facing surfaces of adjacent components are located accurately a predetermined distance apart.

The invention in a second aspect also concerns similar components when made according to the method of the invention.

"Similar" in the context of this invention means that the three-dimensional shapes of the components are substantially identical, but of different sizes, so that when the components are placed in juxtaposition the space between them is defined by facing parallel surfaces of the components.

It is a requirement in many gas turbine engines intended for aircraft propulsion that there be provision for protecting certain parts of the engine against icing, because ice entering moving parts of engines can cause serious damage. In particular, it is important that an engine inlet particle separation system has an effective anti-icing capability.

One known inlet particle separation system is shown schematically in longitudinal cross-section in Figure 1 of the drawings.

Figure 1 shows an inlet particle separator 10 for removing particulate matter from a stream of air

directed into the core (not shown) of a gas turbine engine. The separator 10 comprises an annular air inlet 12 leading to a constriction 14 which sharply turns the air flow radially inwardly so that relatively dense particulate material continues in its original direction into a scavenge duct 16 whilst relatively clean air passes into a clean air duct 18 leading to the engine core. The scavenge duct 16 and the clean air duct 18 are separated by a splitter nose 20.

In order to prevent undesirable icing of the splitter nose 20 it may be provided with a double skin construction comprising two skins 22, 24 separated by a gap 26 through which warming air passes.

It will be appreciated that the splitter nose 20 is a complex three-dimensional shape and that the spacing between the skins 22, 24 has to be manufactured to close tolerances so as to avoid variations in spacing which could result in localised cold spots and possible partial icing of the surface exposed to the clean air stream.

Accurate spacing between the skins 22, 24 depends on manufacturing the layers to a consistently high degree of accuracy so that they are similar shapes. This process is time consuming and expensive, and may result in wasted material if the high degree of accuracy required is not met.

It is an object of the present invention to provide a method of manufacturing a number of similar non-planar components which in use are spaced one from another so that facing surfaces of adjacent components are located accurately a predetermined distance apart.

According to a first aspect of the present invention there is provided a method of manufacturing at least a pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately located a predetermined distance apart when the components, in use, are spaced one from another, the method comprising the steps of,

(a) providing at least a pair of sheets of a first deformable material,

(b) interleaving the sheets of the first deformable material with at least one sheet of a second deformable material to form a laminate of a sheet of the second deformable material between two sheets of the first deformable material,

(c) moulding the laminate to a predetermined non-planar configuration,

(d) fixing the moulded laminate in the non-planar configuration,

(e) removing the laminate from the mould,

(f) separating the sheets of the first deformable material from the moulded laminate, and

(g) discarding said at least one sheet of the second deformable material.

Preferably, the first and second materials are metals or metal alloys.

The first material may comprise a titanium based alloy.

The second material may comprise substantially pure titanium.

Preferably, the method comprises moulding the laminate by a superplastic forming operation.

The sheets in steps (a) and (b) may initially be planar.

Preferably, the at least one sheet of the second deformable material is of constant thickness.

According to a second aspect of the present invention there is provided at least a pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately located a predetermined distance apart when the components, in use, are spaced one from another, when made according to the method of the first aspect.

The invention will now be described by way of example only with reference to Figures 2 to 5 of the accompanying schematic non-scale drawings in which,

Figure 1 is a longitudinal cross-section through an inlet particle separator of the prior art for removing particulate matter from a stream of air directed into the core (not shown) of a gas turbine engine;

Figure 2 is a section through an array of three planar sheets loosely placed one above the other;

Figure 3 is a section through the sheets of Figure 2 when they have been brought into juxtaposition;

Figure 4 shows the section of Figure 3 when the sheets have undergone deformation; and

Figure 5 shows the sheets of Figure 4 when they have been separated one from the other subsequent to the deformation.

The prior art inlet particle separator of Figure 1 has already been described above.

Referring to Figure 2 there are shown three planar sheets 30, 32, 34 placed loosely one on top of the other, sheet 34 being interleaved between sheets 30 and 32. The two outer sheets 30, 32 are made of a titanium alloy of a type that would be suitable for manufacturing the splitter nose 20 of Figure 1, and the interleaved sheet 34 which, for a reason which will become apparent, is of accurately constant thickness over its area, is made of pure titanium metal. It will be appreciated that the titanium alloy and the pure titanium metal are, under suitable conditions, deformable materials.

In Figure 3 the sheets 30, 32, 34 are shown pressed together to form a planar laminate 36. The effect of the pressing is to ensure that the sheets are in contact but are not actually bonded together.

In Figure 4 the laminate 36 of Figure 3 has been superplastically formed or moulded to a desired three-dimensional shape 38, which, as shown, may be that of the splitter nose 20 of Figure 1. The forming may be carried out by any one of a number of superplastic forming or moulding methods (such as explosive forming) which are well known to the man skilled in the art and need not be described here.

In Figure 5 the component sheets 30, 32, 34 of the shaped laminate 38 are separated from each other, and the interleaved sheet 34 of pure titanium is discarded. The shaped sheets 30, 32 are now exactly the desired shape of the splitter nose 20 and may now be assembled to provide a double skin splitter nose in which the spacing between the component skins is provided to a high degree of accuracy. This is because the spacing is initially defined by the pure titanium sheet 34 which, as has been indicated above, is of accurately constant

thickness throughout its area.

The invention hence enables double-skinned components of complex three-dimensional shapes to be manufactured with an inter-skin spacing defined to a high degree of accuracy. By applying the process to a laminate of three or more sheets interleaved with sheets of disposable material it is possible to make complex three-dimensional shapes having three or more skins separated by accurately defined gaps.

Materials other than the titanium alloy and pure titanium exemplified above may be contemplated in the method of the invention, provided they are capable of being formed or moulded as a laminate to a desired shape, either by superplastic forming or by other means, and then subsequently separated. Materials envisaged include other metals such as steel, nickel alloys, aluminium, aluminium alloys, and polymeric materials.

It is furthermore possible with the invention to provide a double or multi skin structure wherein inter-skin spacing can be controlled in specified regions of the structure by controlling the thickness of the disposable interleaved sheet (or sheets). This may be useful if it is desired to modify fluid flow rates within specified parts of the structure.

CLAIMS

1. A method of manufacturing at least a pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately located a predetermined distance apart when the components, in use, are spaced one from another, the method comprising the steps of,
(a) providing at least a pair of sheets of a first deformable material,
(b) interleaving the sheets of the first deformable material with at least one sheet of a second deformable material to form a laminate of a sheet of the second deformable material between two sheets of the first deformable material,
(c) moulding the laminate to a predetermined non-planar configuration,
(d) fixing the moulded laminate in the non-planar configuration,
(e) removing the laminate from the mould,
(f) separating the sheets of the first deformable material from the moulded laminate, and
(g) discarding said at least one sheet of the second deformable material.

2. A method as claimed in claim 1 wherein the first and second materials are metals or metal alloys.

3. A method as claimed in claim 2 wherein the first material comprises a titanium based alloy.

4. A method as claimed in claim 2 or 3 wherein the second material comprises substantially pure titanium.

5. A method as claimed in any preceding claim comprising moulding the laminate by a superplastic

forming operation.

6. A method as claimed in any preceding claim wherein the sheets in steps (a) and (b) are initially planar.

7. A method as claimed in any preceding claim wherein the at least one sheet of the second deformable material is of constant thickness.

8. A pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately located a predetermined distance apart when the components, in use, are spaced one from another, when made according to the method of any preceding claim.

9. A method of manufacturing at least a pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately spaced a predetermined distance apart when the components, in use, are spaced one from another, the method substantially as hereinbefore described with reference to Figures 2 to 5 of the accompanying drawings.

10. A pair of similar non-planar components configured so that facing surfaces of adjacent components are accurately spaced a predetermined distance apart when the components, in use, are spaced one from another, substantially as hereinbefore described with reference to Figures 4 and 5 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

Application number
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Relevant Technical Fields

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(ii) Int Cl (Ed.5) B21D-026

Search Examiner
A R MARTIN

Date of completion of Search
17 FEBRUARY 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASES WPI, CLAIMS

Documents considered relevant following a search in respect of Claims :-
ALL CLAIMS

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	WO 83/02747	(COMPOSITE CONTAINER) see Claim 1	Claim 1 at least
X	GB 2263081	(MITSUBISHI) see Claim 1	Claim 1 at least
X	GB 2019286	(NISSAN) see Claim 1	Claim 1 at least
X	EP 0049744	(KLÖCKNER) see Claim 1	Claim 1 at least
X	US 4642863	(ONTARIO) see Claim 1	Claim 1 at least

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